THE HISTORY AND CONSTRUCTION OF THE

ANACOSTIA BRIDGE AT 11TH ST.S.E.

THESIS PREPARED BY

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FOR INITIATION INTO THE BETA CHAPTER

OF TAU BETA PI FRATERNITY

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SUMMARY

There have been several bridges across the Anacostia which existed previous to the one which now stands there. In 1795 and 1797 the Maryland legislature authorized the construction of two bridges. Again in 1819 the Navy Yard Bridge Co. spanned the river. During President Grant's second administration still another bridge was built and this eventually was replaced in 1907 by the present structure.

The Anacostia Bridge, a steel arch deck type structure, is 1,000 ft. long, between abutments, has a roadway 35 ft. wide and two 6 ft. 6 in. sidewalks. There are 6 steel arch spans 129 ft. 2 in. long and 1 lift draw span 100 ft. long. The piers are concrete throughout. Each steel arch span consists of 6 plate girder arches, each having 3 hinges. As the bridge was built in a country abounding in flats and lowlands the three hinged arch feature was provided to take care of any settlement in the substructure without a coincident movement in the superstructure.

The bridge as it now stands is in a good condition although the south abutment has a wide split from top to bottom, and there has been a slight settlement of this abutment with no damage done thanks to the three hinged arches. The narrow roadway eventually will lead to the replacement of the present structure with one which can more adequately provide for large streams of traffic.

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The writer also wishes to express his appreciation of the information and help given him by R. E. Sherry and J. C. Ricker, operators for many years of the draw on the present bridge; Mr. Houser, assistant engineer of bridges of the District of Columbia, and Mrs. H. E. Way.

INTRODUCTION

The Eastern Branch of the Potomac River, otherwise known as the Anacostia River, since the early settlement of the region surrounding it, has, up to the present time, remained a source of controversy and civic dispute. The gradual building up of the nation's capital offered the farmers of the countryside a market of no mean size, and to transport farm products from the southeast the Anacostia River had to be crossed. This in itself constituted no great problem for engineers of that day, for building a bridge across a river some 1540 ft. wide was simple enough. Being primarily concerned with transportation facilities the engineers spanned the river with bridges and left for a later day the discordant problems of reclaiming the flats and swamps of Anacostia.

HISTORY

EARLY HISTORY

Records of the first bridges built across the Anacostia River show that the Maryland Legislature in 1795 and again in 1797 granted charters for the building of toll bridges across the Eastern Branch. These two structures were commonly known as the Upper and Lower Bridges. The former was erected by the American Bridge Company and was just off Kentucky Avenue at about Benning where the river had a width of 1,543 ft., a depth at common low tide of 4 ft. and a channel 12 to 14 ft. in depth and 450 ft. wide. This first bridge cost $18,000, was 25 ft. wide and 1600 ft. long. It was constructed of wood resting on piles and there was a draw over the channel which had a depth of 24 ft. at that point. The river at that time was deep enough for ocean going vessels to clear at the Port of Bladensburg. Soil erosion, brought about by the stripping of

forests, has since clogged up the river, but as late as 1843 a brig sailed out of Bladensburg with a cargo of tobacco.

The bridge of 1797 was about a quarter of a mile above 11th Street and was constructed by the Eastern Branch Bridge Company. It was a drawbridge.

Both of these early structures were partially burned by American forces upon the approach of the British in 1814 to prevent invasion of the capital. The marines under Captain Creighton burned the lower bridge and seemingly without military justification, for the enemy had already crossed the river at Bladensburg and later on retired the same way, which to them was just as convenient and more safe.

Nearly a year later Congress recompensed the American Bridge Company with appropriations of $20,500 for repairs. The Lower Bridge continued in general use until about 1841, after which it was used only for foot travel. In 1846 sparks from a passing excursion steamer ignited the draw and the bridge was completely burned, never to be rebuilt.

This "Burnt" Bridge was the outlet and inlet for the trade and travel of southern Maryland until the construction of a new bridge at the Navy Yard in 1820 by the Navy Yard Bridge Company which was incorporated in 1819 by William Prout, S.N.Smallwood, Timothy Winn, Adam Lindsay, and William Marbury. The directors of the Eastern Branch Bridge Company, whose bridge was only a short distance to the East, protested in vain against its erection, for it meant the division of Maryland trade with the newer structure collecting the lion's share of tolls. Incidentally, the matter of toll collection was causing trouble. Maryland inhabitants claimed they were discriminated against because bridges linking the District of Columbia and Virginia were free. This agitation, which started in 1844, culminated in the purchase of the "Upper Navy Yard Bridge" by the government in 1848 , when it was made free, though

no one can say in what part this was due to any claims of discriminations against Maryland.

The bridge had a rather tragical historical background, for John Wilkes Booth, who assassinated Lincoln on the night of April 14, 1865, left the city with his accomplice by way of this old wooden structure. A military guard was still posted on the bridge but as the war was over restrictions were relaxed and the two were allowed to pass unmolested.

LATER HISTORY

This Bridge of 1819 was removed during President Grant's second administration as it was considered a menace to safety and an invitation to calamity. Congress in 1874 authorized the construction of a "substantial iron and masonry bridge across the Anacostia River at or near the site of the present Navy Yard bridge" and appropriated $146,000.

The new bridge had masonry piers, a wooden floor, and iron framework. It was wide enough for two street car tracks. It was located south of the bridge which now spans the river and was 20 ft. lower. According to R. E. Sherry and J. C. Ricker, the operators of the present draw and old inhabitants, in the construction of the bridge piles were sunk on which were placed 12" x 12" white pine timbers. These were covered by 3" board and on this substructure the masonry piers were built. Loose rocks and stones were placed around the base of the piers. The draw had a span of only 28 ft. and was hand operated. The bridge was extremely

low and when the river was high a row boat could not pass under the bridge. However, this new structure proved inadequate in a comparatively short time for in 1897 another bridge was recommended with the suggestion that the old spans be used to bridge Rock Creek. In 1903 the engineer of bridges of the District of Columbia in a report stated that the bridge had been structurally week for 15 years, due in no small part to the heavy cars of Anacostia and the Potomac River Railroad Company. He also reported that " a careful determination of stresses in the bridge under the existing conditions and according to modern bridge practice clearly shows that the bridge is stressed throughout 100 percent in excess of good practice and that the hanger posts in many cases are stressed within a few percent of their ultimate strength." Because of its narrowness and unsafe condition the replacement of the bridge was recommended. The recommendation was eventually carried out, for by acts of Congress in 1904 and 1905 a total of $375,000 was appropriated for the replacement of the old structure by the present bridge at the foot of 11th Street. With such a limited amount of money it was deemed advisable for artistic and economic reasons to construct the steel arch deck type of bridge with a lift draw.

CONSTRUCTION OF THE PRESENT BRIDGE

The bridge is 1000 ft. long between abutments and contains six steel arch spans 129 ft. 2 in. long, and 1 lift draw span 100 ft. long. The roadway is 35 ft. wide and there are two sidewalks 6 ft. 6 in. wide in the clear. The bridge is so designed to carry two railroad tracks with each track capable of carrying a forty ton car. Sidewalks are designed to carry 90 lbs. per square foot. There are four ordinary piers supporting the arch spans and two main piers each of which carries one arch span and one-half of the draw span. The piers are concrete throughout and rest on pile foundations. The foundations were so designed that the channel of the

river could be widened to 600 ft. with a depth of 22 ft. below mean low water.

Each arch span consists of 6 plate girder arches, each having three hinges; one at the crown and two at the springing lines. This arrangement was used to permit slight settlement in the foundation which takes place in the pile structure without detriment to the superstructure. Present day observations of the bridge show that the use of the three hinged arches was a wise move, for as was forseen, there has been a settlement in the foundation. The south abutment has settled toward the north thus increasing the natural camber of the first arch. The north pier of the draw span has settled toward the south, thus flattening the adjacent north span.

The piles were driven to satisfactory refusal in the stream bottom. The piers were carried down to about 22 ft. below mean water level and the piles extended from thereon about 25 ft. further. Six preliminary test piles were driven. At the site of each pier and abutment when the bottom was dredged to the required depth and where the material was soft, sand was filled in to a depth of 2 ft. around the tops of the piles to make a bed for the concrete. The piles were designed to take a maximum load of 15 tons each. They are pine or oak 12 in. in diameter at the butt and most of them 40 ft. long after being cut off. It was required that they should be driven to a refusal of 1/3 in. under a 15 ft. drop of a 2,000 lb. hammer. There are 410 or 420 piles in each of the 6 piers and in the north and south abutments there are 258 and 405 piles. respectively. The total number of piles is 3087.

The substructure is entirely monolithic concrete carried up to the subgrade for the roadway and extended above that on the sides of the bridge to form the parapet walls. These walls are not built continuously with the lower part but are keyed to it.

The abutments form in plan 3 sides of a rectangle with vertical faces and their walls extended are offset at the base to resist the thrust of the earth fill. The piers for the draw span are about 31½ ft. wide, 64 ft. long at the base and 55 ft. wide above the tops of the piles. They are rectangular in plan and are chamfered to receive the buckleplates and the machinery for operating the bascule leaves. Cofferdams, made of tongue and groove sheet piling, were driven around the foundation piles. These cofferdams were subject to complete removal or they could be cut off to 1 ft. below low tide 2 months after the completion of the concrete.

The piers are made of 1:3:7 Portland cement except in the footings which are 1:2:5. The footing concrete was deposited under water around the pile heads by means of a steel tremie pipe with flexible joints. The concrete formed the bottom of the cofferdams which were then pumped dry so that molds could be constructed and braced in the usual manner. All sand and gravel used in the concrete was carefully selected and graded.

On each intermediate pier 12 sets of I beam grillages in inclined planes are bedded in the concrete to form supports for and distribute the pressure from the skewback shoes of the superstructure. Each grillage is made with 8 horizontal 10 in. 25 lb. I beams bolted together with 2 lines of standard cast iron separators. Just above the water level the battered surfaces of the piers are finished with a belt of 1:2:4 concrete 6 in. thick and about 5 ft. high (to resist impact from floating objects).

The piers are built without reinforcement except those for the bascule span which have 2 pairs of 1 in. horizontal steel bars 12 in. apart $3\frac{1}{2}$ ft. above the pile tops. In these piers also there are platforms of I beams built into the base of the masonry to anchor the superstructure. Each of the six fixed spans has six three hinge plate girder arch ribs spaced 4 ft. 6 in., 12 ft. 3 in. and 21 ft. 3 in. from the axis of the bridge. Each rib is made of two semi arch girders $4\frac{1}{2}$ ft. deep with parallel flanges, the lower one curved to a radius of 147 ft. The span from the center of the skewback pins is 128 ft. $4\frac{1}{2}$ in. and has a rise from the center of the skewback pin to the center of the crown of 14 ft. 6 in.

A deflection of $\frac{1}{2}$ in. is calculated for the dead load of the bridge and 3/8 in. for the maximum uniformly distributed live load. The span is divided into twelve 10 ft. $1\frac{1}{2}$ in. panels and at the panel points supports are provided for the floor system. These supports are vertical spandrel columns at the end of the arch and between them there is in the center and two outside panels of each transverse plane X bracing of single angles at the 1st and 2nd panel points.

The center of the sidewalk is nearly coincident with the outside girders, and a portion of the sidewalk, together with the handrail, is cantilevered beyond the girders with brackets. The sidewalks are flat concrete slabs made in two thicknesses; the lower one is 2 in. thick and is made of 1:2:4 concrete; the upper one is 1 in. thick and is made of 1:$1\frac{1}{2}$ mortar reinforced by a continuous sheet of No. 10 wire mesh.

The roadway is crowned transversely where the stringers are supported directly on the masonry. Double curved girders confine the roadway material at the ends of the span where an expansion joint is provided and covered with a checkered steel plate riveted to one girder and sliding freely on the top of the other.

The roadway is crowned transversely and at each of intermediate piers drainage is provided through special vertical cast iron pipes fitted to the girders under the edge of the sidewalk. The estimated quantity of steel is 3,630,000 lbs. including the machinery. The draw span and the machinery weigh 761,000 lbs. exclusive of flooring and each of the regular spans weighs 446,500 lbs. Semi arch girder ribs were shipped complete from the shops and weigh 7 tons for the outer to $10\frac{1}{2}$ tons for the middle girder. The amount of concrete in the substructure is 15,450 cu. yds.

The draw span has a clearance of 24 ft. above low water and a span of 100 ft. It is designed to operate in less than a minute against a direct 50 mi. per hour wind. To know when the draw has about reached its maximum height the men who operate the bascule have marked a line on the window frame of each of the operating houses. When the top of the hand railing of the draw coincides with the line, the machinery is stopped. If the leaf is carried much higher a circuit breaker automatically cuts off the current. The south leaf is raised first and put back in place last. The counter-balanced leaves are provided with a locking device at the center of the span and are supported on fulcrum pivots and reaction girders on the piers.

In each leaf there is one principal plate girder cantilever $16\frac{1}{2}$ ft. on each side of the axis; they are 80 ft. $\frac{1}{2}$ in. long and 10 ft. deep overall. These are pivoted on 21 in. horizontal axles dividing them into short and long arms of 21 ft. $4\frac{1}{2}$ in. and 58 ft. 8 in. They are braced together with deep web connected plate girder floor beams and knee braces and top and bottom laterals and carry between them the street car tracks and roadway. The $6\frac{1}{2}$ ft. sidewalks are cantilevered outside the girders with solid web brackets riveted to the vertical web stiffener angles of the main girders and secured to their top flanges with tension splices. Flanges of the main girders are reinforced with numerous horizontal coverplates, and

near the pivot, have vertical reinforcement plates besides.

The trunnion is of forged steel about 8 ft. long $20\frac{1}{2}$ in. in diameter in the center and 15 in. in diameter on the end bearings and is bored with a $2\frac{3}{4}$ in. hole through the axis. At its extremity the web of the short arm is stiffened by vertical and diagonal angles and is enclosed in a rectangular steel plate box 5 ft. wide and 10 ft. long extending the full depth of the girder and containing about 45,000 lbs. of cast iron and 2,800 lbs. of concrete on each leaf for counterweight. At the end of the short arm the upper corner of the web is notched and horizontal angles are riveted to the lower part to provide a seat engaging the lower flange of the horizontal transverse anchorage reaction girder. Opposite the pivot a segmental rack casting about 12 ft. long with an 8 ft. radius is bolted to the lower flange of the cantilever girder and engages the 22 in. driving pinion which is located between the supports for the girder, and is geared to a transverse horizontal shaft driven by 2 General Electric 38 h.p. motors of the railway type. The motors and operating machinery are set in the walls at each end of the span and are separately controlled from the operating houses above by brake bands and by a controller and resistance. Each pair of motors has a series-parallel controller fitted with interlocking cylinders and pneumatic blow-out. The resistance is so designed that the motors can be brought from standstill to full speed without causing sparking at the commutators or shock or jar to the bridge. The gear wheels are cast steel throughout and their cut teeth have involute curves of 15 degrees obliquity with radial line extensions below the involute base circles on the teeth and addendum curves on the large wheel cut inverse with dedendum lines for a 12 tooth opening. Curves are exact to within 1/32 in. and metal is proportioned for a working stress of 20,000 lbs per sq. in.

All forgings are annealed and all adjustment bolts have double nuts. The trunnion bearings are provided with compression grease cups designed for a working pressure of 600 lbs. per sq. in. Motors are operated by current from the 500 volt metallic circuit street railway feeders on the bridge. Handgear is also provided to capstan heads in the floor for the operation of the bascules.

When the bridge is closed to navigation the long arms of the opposite cantilevers are locked together and the girders take bearing between the fulcrums. The extremities of the short arm engage the reaction anchorage girders through spring buffers. The buffers have a vertical movement of about 2 in. At the center of the span the adjacent ends of the cantilever girders are locked together when the bridge is closed by a horizontal 4½ in. steel pin which passes through the overlapping webs of the girders. This pin moves back and forth in a cast steel guide block and is operated by long links commanded by a hand wheel installed in one of the operating houses. The east end of south pier and the west end of the north pier are operating houses. The duplicate houses are for storage of tools, oil, etc. The houses are of reinforced concrete with an exterior finish to resemble cut ashlar. They are about 15 ft. long 6½ ft. wide, 14½ ft. high over all with an arched roof 6 in. thick reinforced by 2 layers of 3/8 in. steel rods 12 in. apart. Walls are reinforced by 3/8 in. vertical rods 6 in. apart and by horizontal rods.

The operating houses contain the switchboard, brake, controller, and locking gear. A trap door leads to the pier. The houses were provided with electric heater but these have been replaced by stoves for economy.

When the draw is opened a green light automatially flashes as a passable height is reached. The leaves of the draw are inclined at an angle of about 55 degrees with the horizontal when fully open. The distance between the leaves of the draw is about $\frac{1}{2}$ in. in the summer and 1 in. in the winter. This allowance for expansion is sufficient for ordinary conditions, but it is interesting to note that in July 1930 the extreme heat locked the draw fast. No damage was done except that traffic was delayed. At the present time the draw is not used more than once or twice in several weeks.

From 1912 to 1915 the draw was operated from 6 oclock in the morning to 10 o'clock at night. Since then, however, it has operated from 9 A.M. to 5 P.M. A night watchman stays on the bridge the rest of the time.

The bridge and machinery was designed in the office of Mr. W.J. Douglas, engineer of bridges of the District of Columbia, with Mr. T. Wilson, Jr. in charge of structural work and Mr. T. C. Bailey, Jr. in charge of masonry work and construction under the direction of Col. John Biddle, U.S.A., engineer commissioner and Capt. J.J.Morrow, U.S.A., assistant to the engineer commissioner,Washington, D.C. The contract was awarded to the Penn Bridge Company of Beaver Falls, Pennsylvania for a total sum of $340,000 exclusive of approaches.

Several repairs have been made on the bridge since its erection. The floors were reconstructed in 1930 one side at a time thus allowing traffic to continue. The original buckle plates were replaced with reinforced concrete slabs and a new asphalt surface was laid. A timber floor system on steel members was constructed on the draw span. These repairs

and a new handrail cost approximately $104,000

CONCLUSION

In conclusion, what could by more appropriate than to scan hastily the glamorous past of the Anacostia and its bridges. First are flats and swamps, breeding disease. But the river must be crossed, so flimsy structures are built. And then the British! Burn the bridges! Save Washington. And now to build another bridge, better than the last, to offer a means of travel to all who seek it, even to John Wilkes Booth and his companion who come fleeing from a crime that shocks the world. Time passes. Still the swamps and the lowlands breathe death and destruction and the choked river flows sluggishly beneath a rotting structure. Then build yet another bridge and when time has taken its toll still another. And call this last a "Bridge of Sighs" for the clatter of the horses feet on its wooden planks means the "place across the river", St. Elizabeth's.

And now listen to the angry citizens demanding relief by reclamation from the flats of Anacostia. But let them wait; first build a new bridge, one of steel and concrete, a bridge of beauty and strength, a modern structure for a modern city. A modern city? But the swamps and the reeking lowlands? Fill them in! Build parks, lakes, playgrounds, and tree lined drives - and then - wait again for time and politics to raise a new memorial to man's ingenuity and the engineer's usefullness.

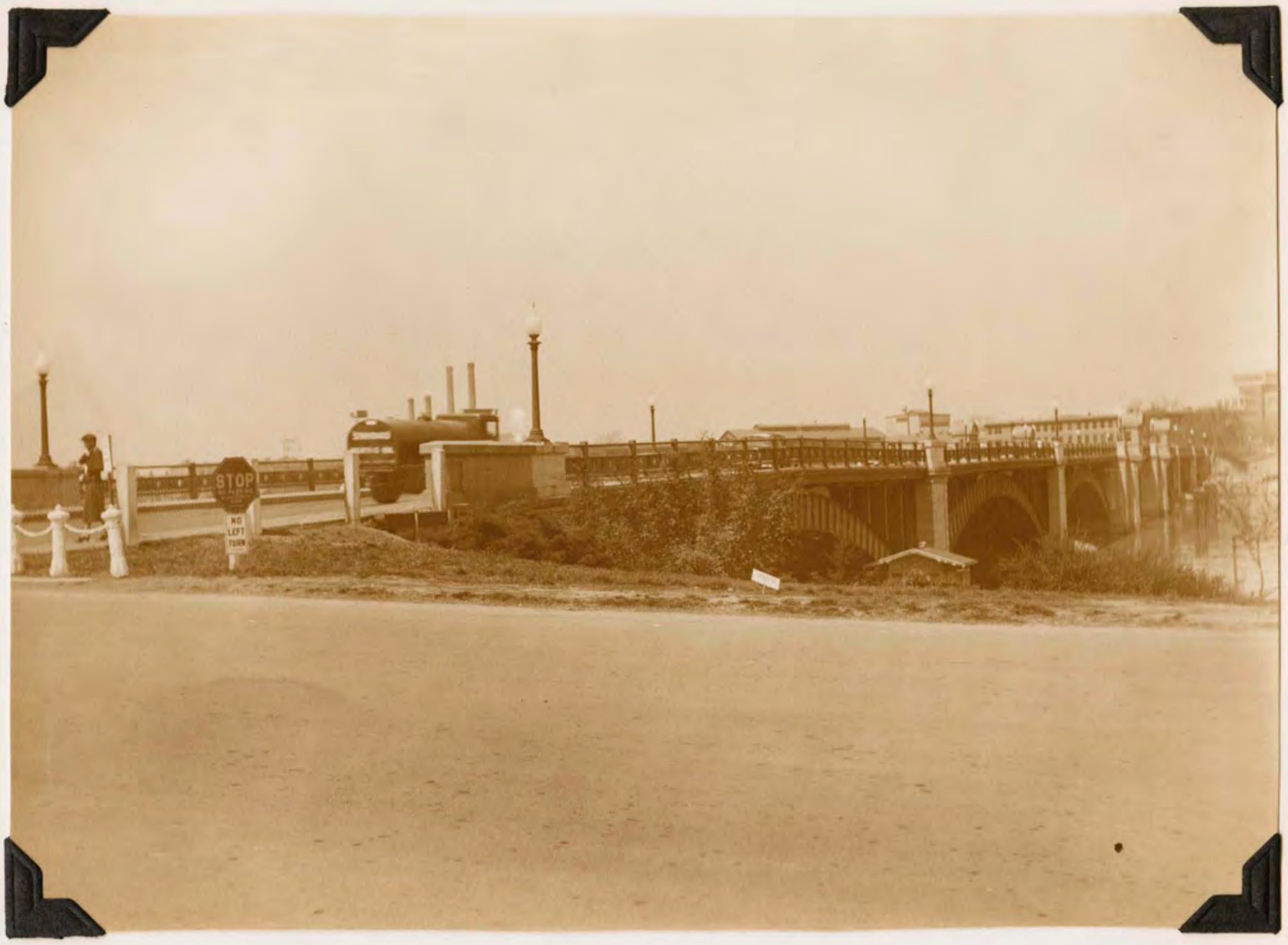
View from the Anacostia side showing also the Navy Yard and the old bridge downstream.

Looking north from the Anacostia side of the river.

Abutment and first span,south (Anacostia) end of bridge.

Inscription on the north approach.

View showing how settlement inward of the south abutment has put a hump in the adjacent three hinged arch. This abutment also has a large crack from bottom to top, widening to about 2 inches.



Note the twisted appearance of the arches due to settlement of the substructure and south abutment.

Looking northwest toward the Navy Yard.

One of the four small houses next to the bascule.

The first pier on the south side.

The north abutment of the old bridge with the Navy Yard in the background.

South abutment of the present bridge. Repairs are being made on the sewer on the right, whose walls have been crumbled by vibration of the bridge.